MODIS Atmosphere Products

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➢ **MODIS atmosphere products**

  – Contents and changes in Collection 5

  – Examples from Aqua (Collection 5)

   ✓ Cloud fraction

   ✓ Cloud top properties

   ✓ Cloud optical & microphysical properties

    » Uncertainties

    » Multilayer flag

   ✓ Aerosol properties

    » Aerosol optical thickness & fine mode fraction

    » Deep blue algorithm for desert surfaces

   ✓ Water vapor

   ✓ Zonal cross sections

  – Probability density functions (Collection 4)

Gridded Level-3 Joint Atmosphere Products
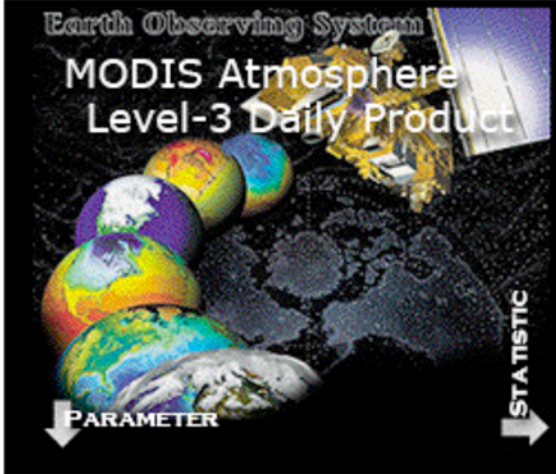## (M. D. King, S. Platnick, P. A. Hubanks – NASA GSFC)

- Daily, 8-day, and monthly products (97, 255, 255 MB)
  - 20-25% of the size of these products in Collection 4
  - Files contain more SDSs, but are stored with internal hdf compression
- 1° ×1° equal angle grid
- Statistics
  - Mean, standard deviation, minimum, maximum
  - QA mean, QA standard deviation
  - Cloud fraction, pixel counts
  - Log mean, log standard deviation (useful for cloud inhomogeneity studies)
  - Mean uncertainty, QA mean uncertainty
  - Marginal probability density functions for cloud properties
    - ✓ Histogram counts, confidence histograms
  - Joint probability density functions
    - ✓ Joint histograms between various cloud properties (e.g., cloud optical thickness vs cloud top pressure)

Daily Global (08_D3) statistics from
Cloud (06_L2)

Collection 5 Updates

- ▢ Added
- ▢ Renamed
- ▢ Deleted

– Cloud Optical Properties
  - ✓ Primary Retrieval

Full details at
modis-atmos.gsfc.nasa.gov

Earth Observing System
MODIS Atmosphere
Level-3 Daily Product

PARAMETER / STATISTIC

Parameter	Mean	Standard Deviation	Minimum	Maximum	QA_Mean	QA_Standard Deviation	Histogram_Counts (n)	Confidence_Histogram (4)	Fraction	Pixel_Counts	Mean_Uncertainty	QA_Mean_Uncertainty	Log_Mean_Uncertainty	QA_Log_Mean_Uncertainty	Log_Mean	Log_Standard Deviation	QA_Log_Mean	QA_Log_Standard Deviation	Regression_Slope	Regression_Intercept	Regression_R-Squared	Regression_Mean Square Error	Joint_Histogram vs Effect_Radius (nxn)	Joint_Histogram vs Temperature (nxn)	Joint_Histogram vs Emissivity (nxn)	Joint_Histogram vs Pressure (nxn)
Derived from L2 Cloud (06_L2)																										
Cloud Optical Properties (Primary Retrieval)																										
58. Cloud_Optical_Thickness_Liquid	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•					•	•	•	•
59. Cloud_Optical_Thickness_Ice	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•					•	•	•	•
60. Cloud_Optical_Thickness_Undetermined	•	•	•	•	•	•									•	•	•	•								
61. Cloud_Optical_Thickness_Combined	•	•	•	•	•	•									•	•	•	•								
62. Cloud_Optical_Thickness_ISCCP[8]																										•
63. Cloud_Effective_Radius_Liquid	•	•	•	•	•	•	•	•			•	•											•	•	•	•
64. Cloud_Effective_Radius_Ice	•	•	•	•	•	•	•	•			•	•											•	•	•	•
65. Cloud_Effective_Radius_Undetermined	•	•	•	•	•	•																				
66. Cloud_Effective_Radius_Combined	•	•	•	•	•	•																				
67. Cloud_Water_Path_Liquid	•	•	•	•	•	•	•	•			•	•														
68. Cloud_Water_Path_Ice	•	•	•	•	•	•	•	•			•	•														
69. Cloud_Water_Path_Undetermined	•	•	•	•	•	•																				
70. Cloud_Water_Path_Combined	•	•	•	•	•	•																				
71. Cloud_Phase_Optical_Properties																							•			
(Primary Cloud Fraction)																										
72. Cloud_Fraction_Liquid									•	•																
73. Cloud_Fraction_Ice									•	•																
74. Cloud_Fraction_Undetermined									•	•																
75. Cloud_Fraction_Combined									•	•																

Monthly Mean Cloud Fraction
(S. A. Ackerman, R. A. Frey et al. – Univ. Wisconsin)

April 2005 (Collection 5)

Aqua
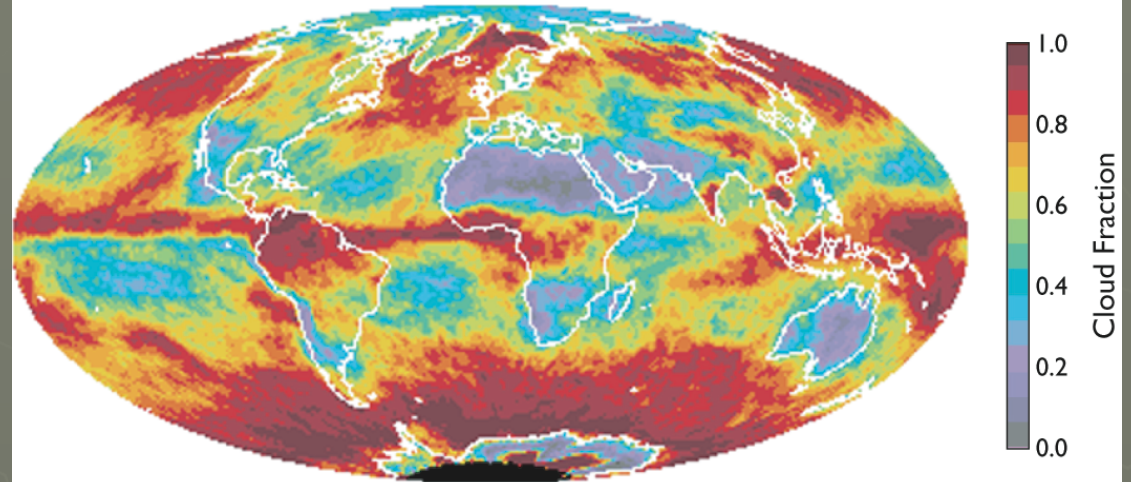
Zonal Mean Cloud Fraction
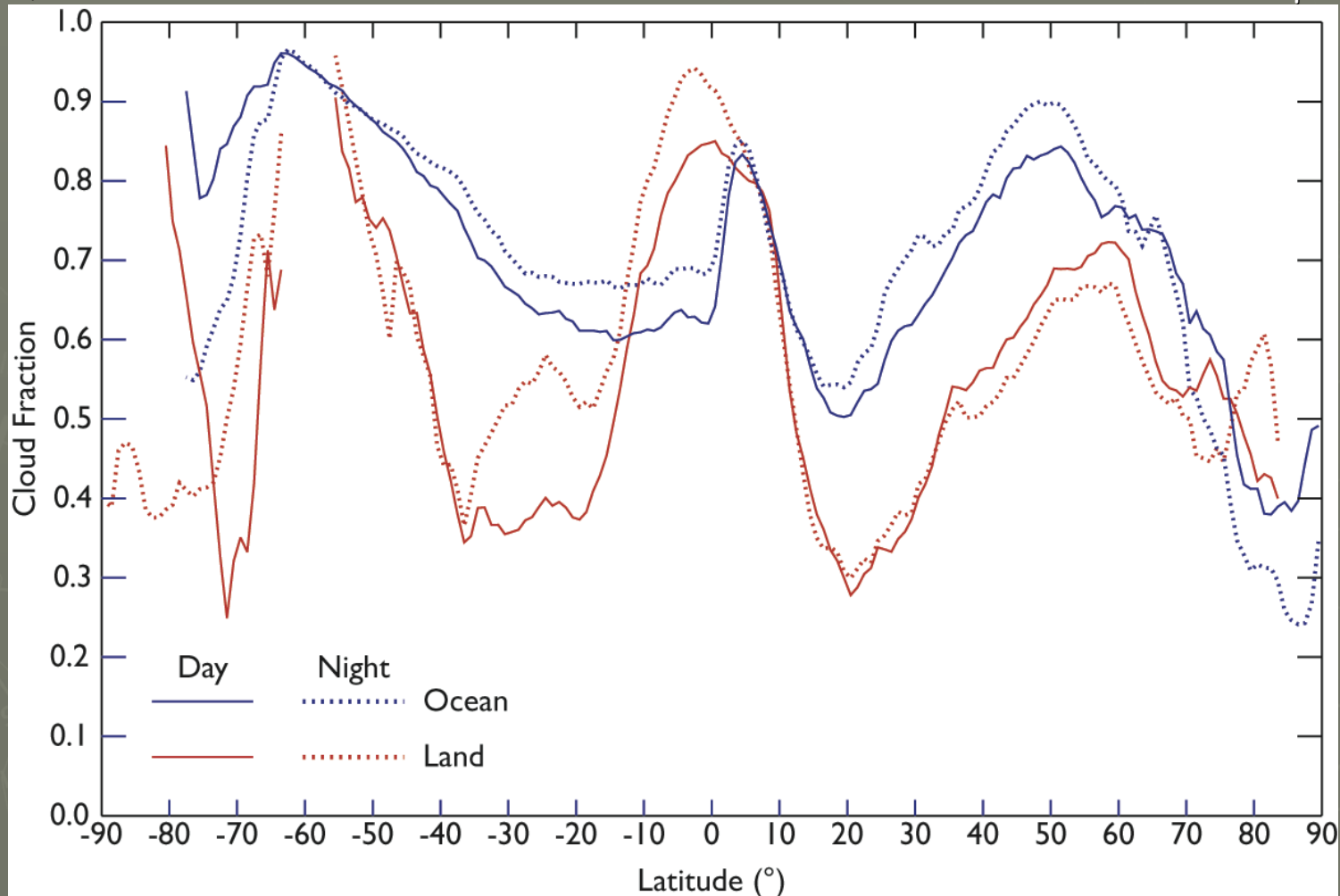## (S. A. Ackerman, R. A. Frey et al. – Univ. Wisconsin)

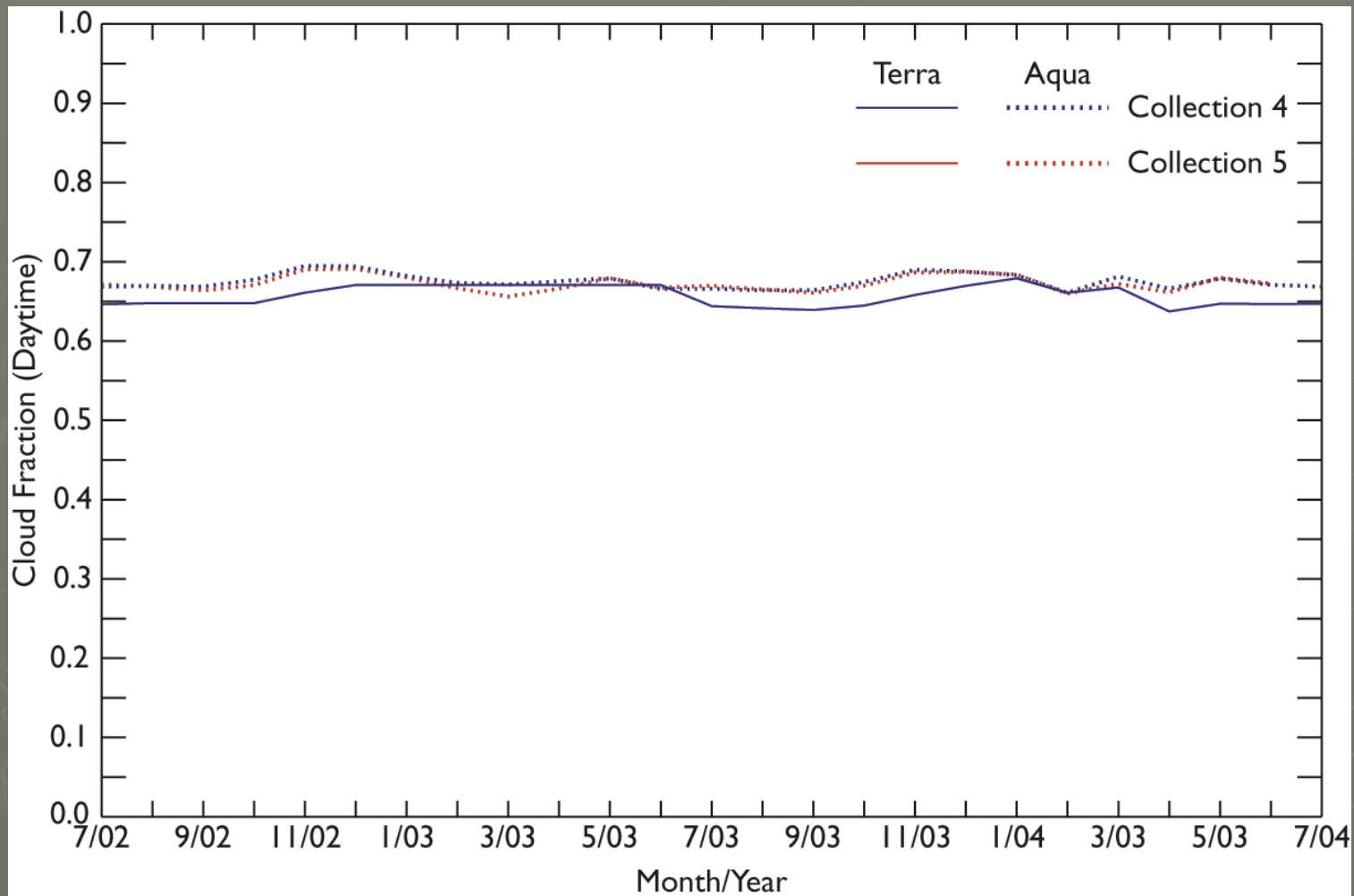April 2005 (Collection 5)   Aqua

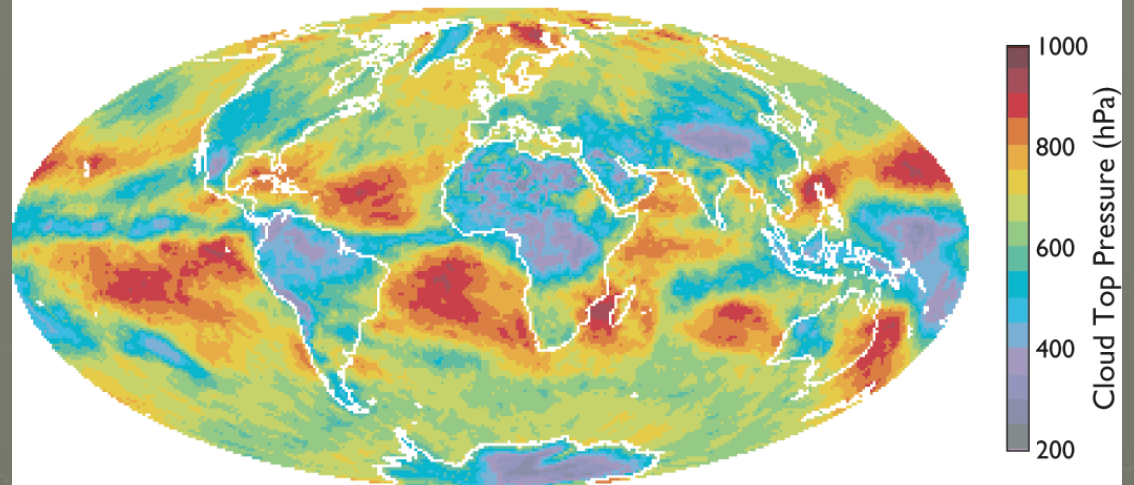# Time Series of Cloud Fraction during the Daytime
(M. D. King, S. Platnick et al. – NASA GSFC)

July 2002 - July 2004

Monthly Mean Cloud Top Properties
(W. P. Menzel, R. A. Frey et al. – NOAA, Univ. Wisconsin)

April 2005 (Collection 5)
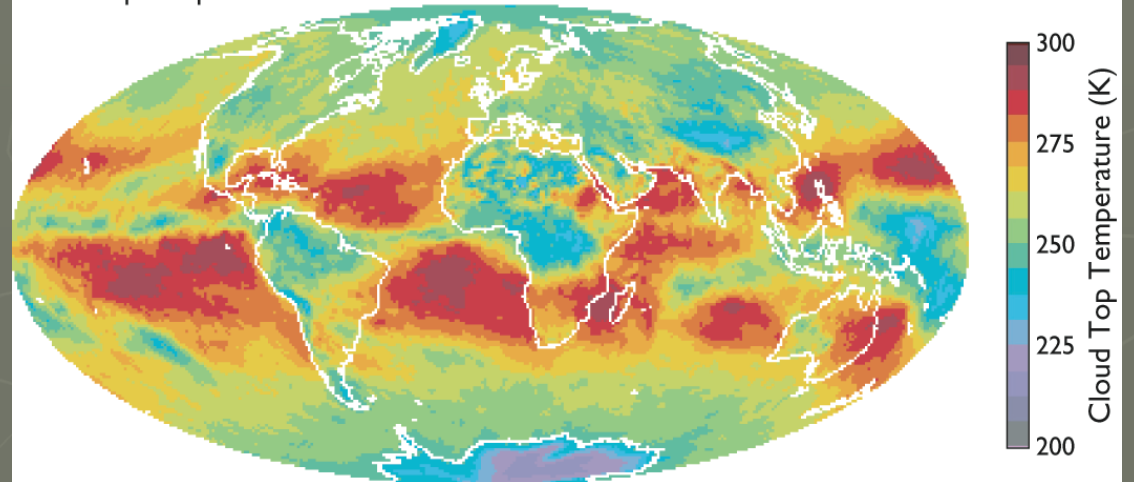
Aqua

Zonal Mean Cloud Top Pressure
(W. P. Menzel, R. A. Frey et al. – NOAA, Univ. Wisconsin)

April 2005 (Collection 5)   Aqua
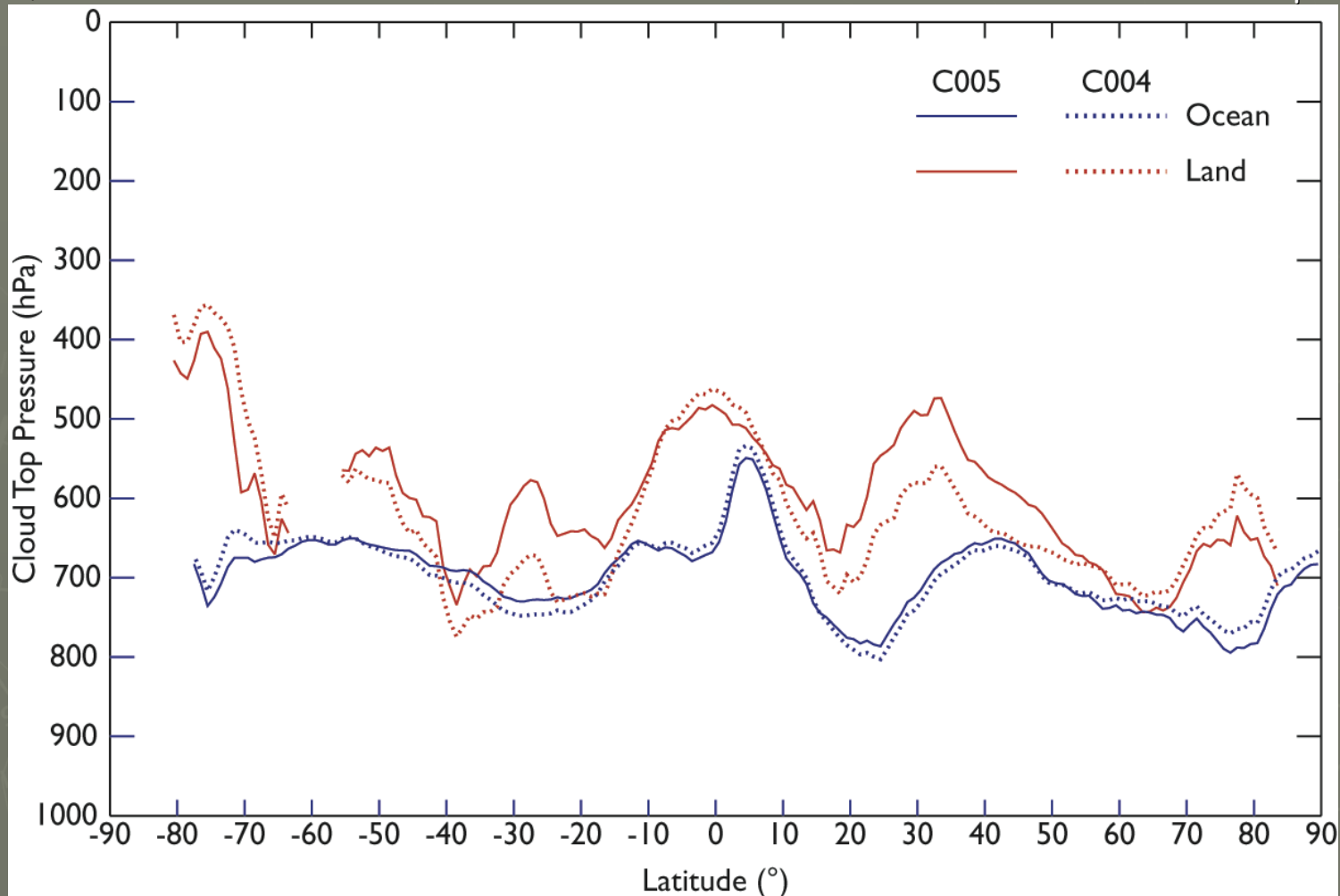
Monthly Mean Cloud Fraction by Phase
(M. D. King, S. Platnick et al. – NASA GSFC)

July 2006 (Collection 5)

Terra

Cloud Fraction (Liquid Water)
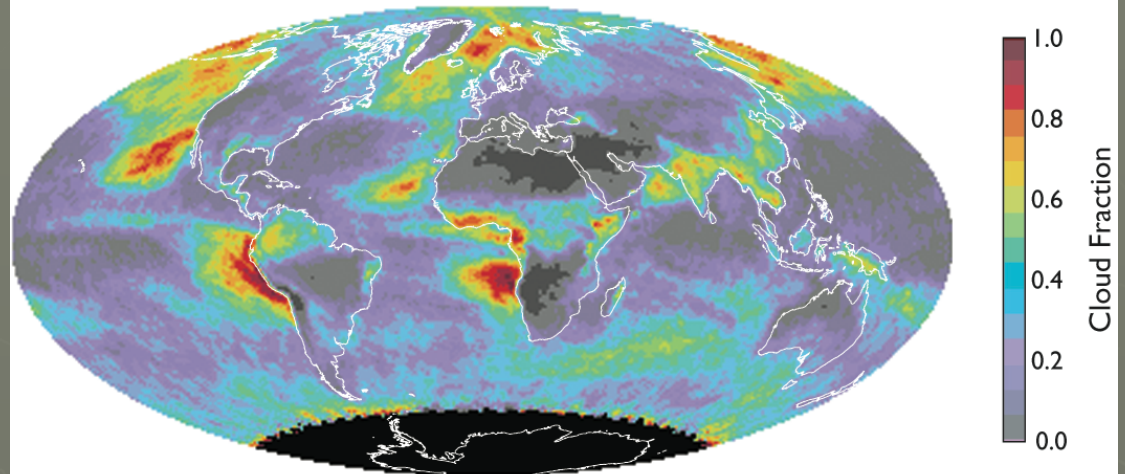
Cloud Fraction (Ice)
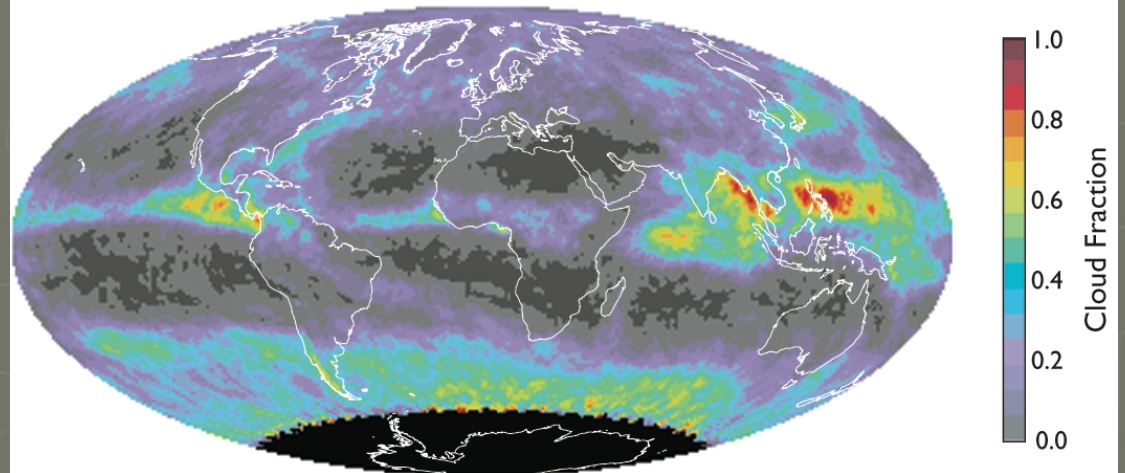
Monthly Mean Cloud Optical Thickness
(M. D. King, S. Platnick et al. – NASA GSFC)

April 2005 (Collection 5)

Aqua (QA Mean)

Cloud Optical Thickness (Liquid Water)
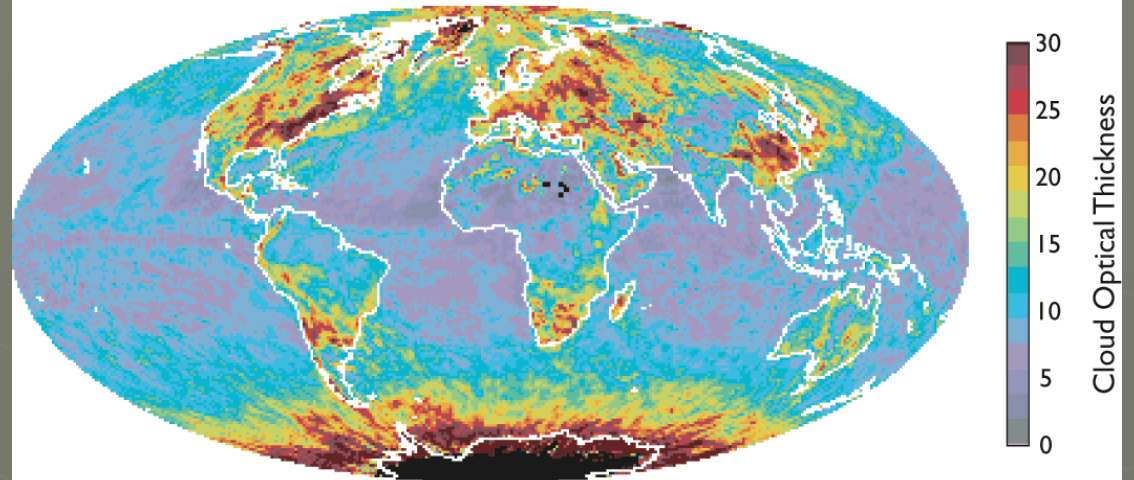
Cloud Optical Thickness (Ice)
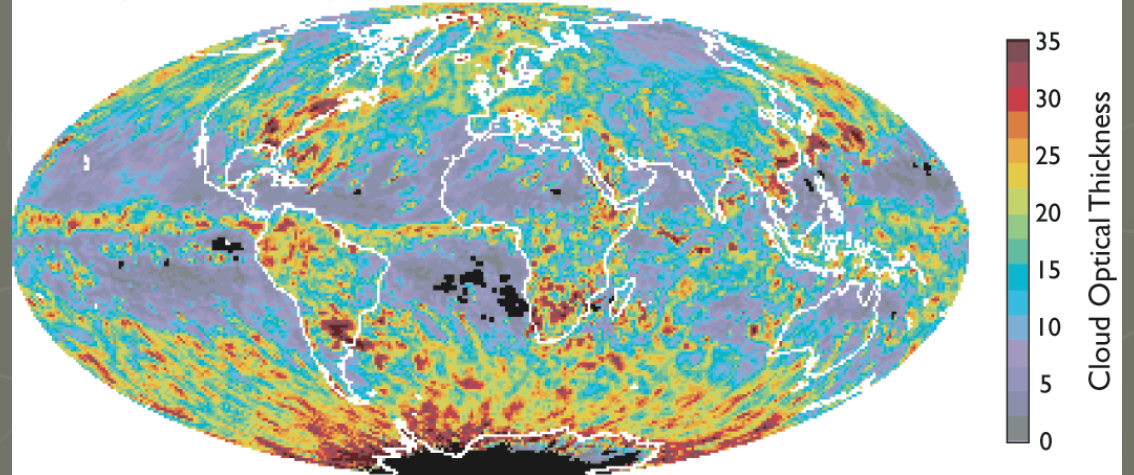
Monthly Mean Cloud Effective Radius
(M. D. King, S. Platnick et al. – NASA GSFC)

April 2005 (Collection 5)

Aqua (QA Mean)
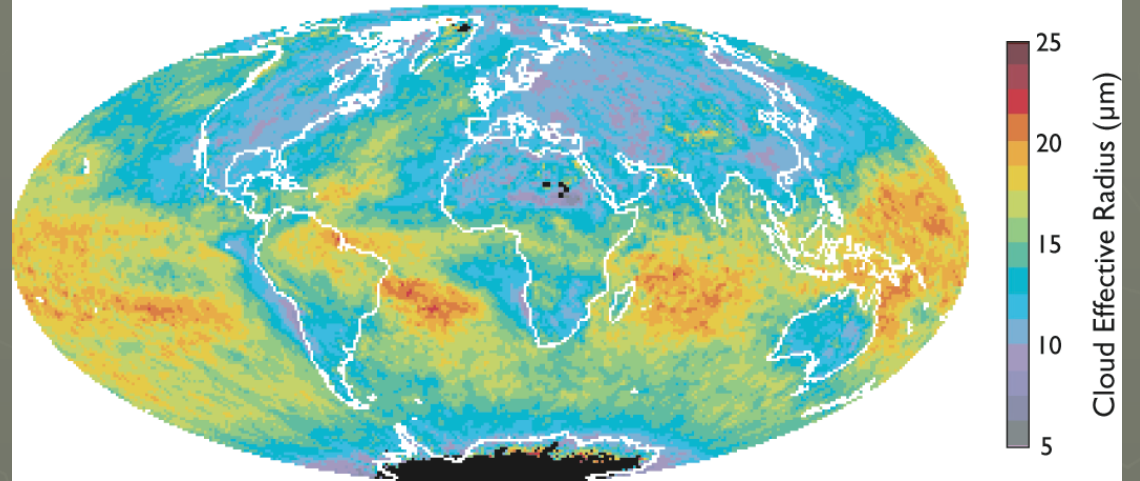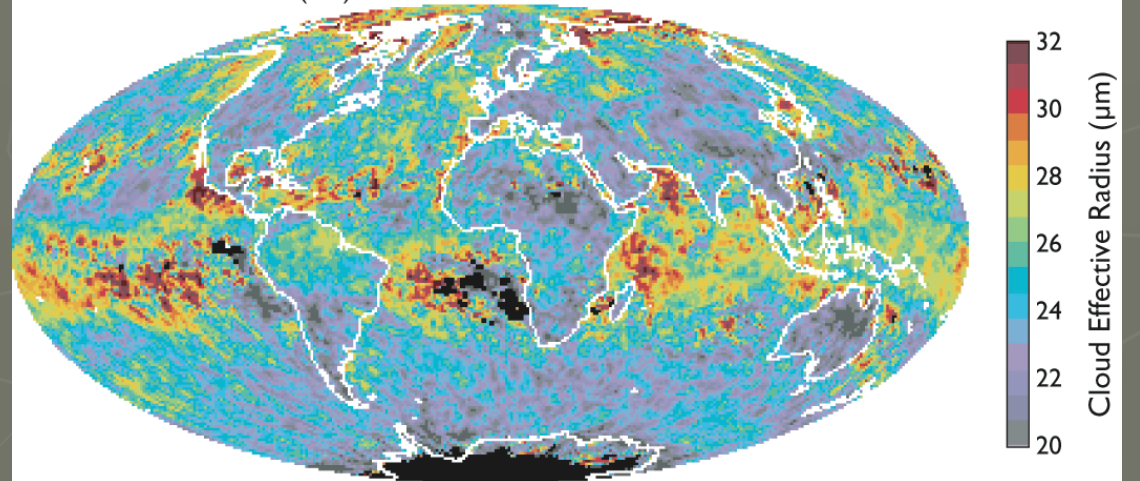
Zonal Mean Cloud Effective Radius
(M. D. King, S. Platnick et al. – NASA GSFC)

April 2005 (Collection 5)   Aqua
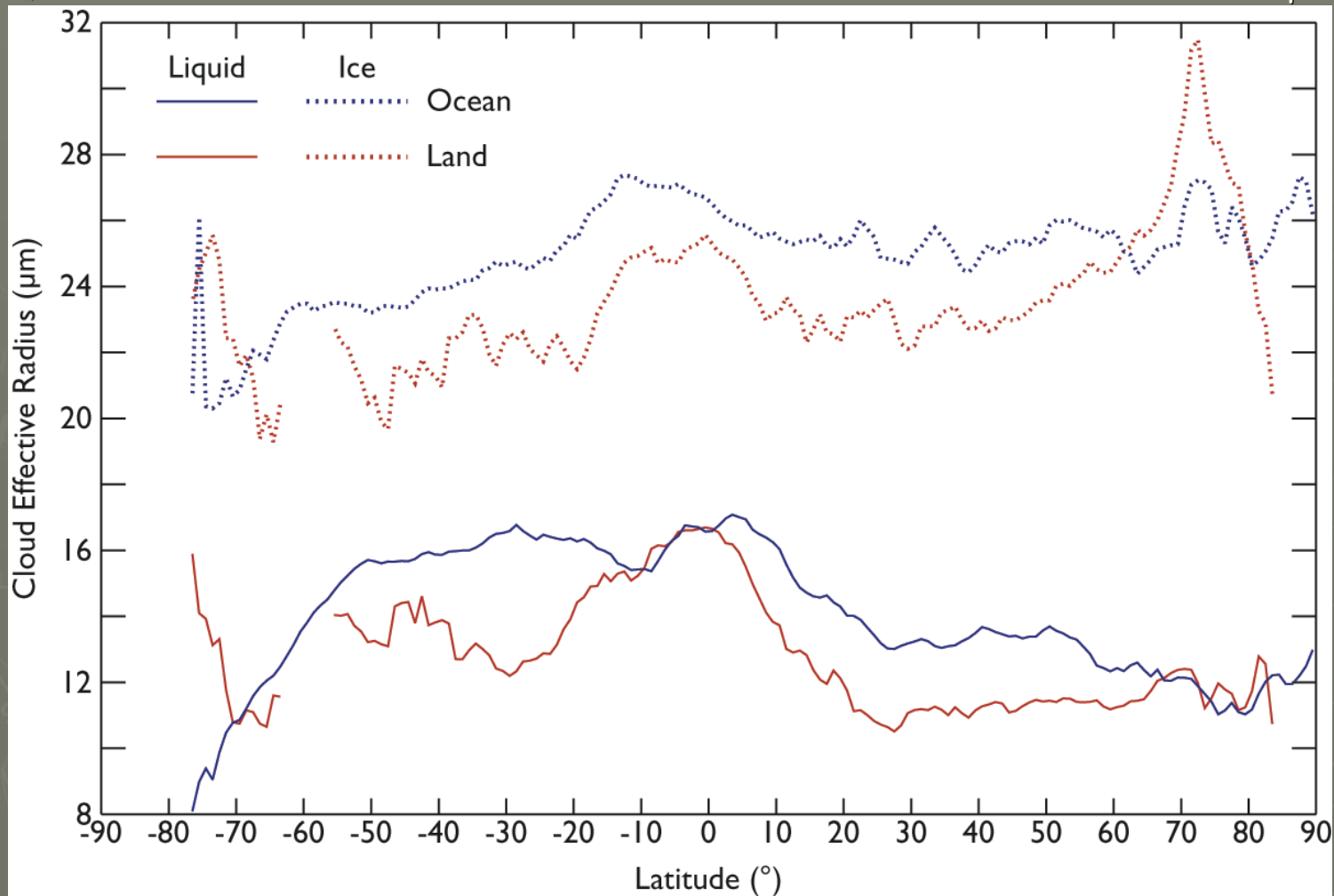
Cloud Effective Radius Uncertainties
(S. Platnick, R. Pincus, et al. – NASA GSFC, NOAA CDC)

Liquid Water Cloud (Collection 5)

$\Delta r_e / r_e$ (%)

Daily Aggregation

(correlation between pixels = 1)

Monthly Aggregation

(daily uncertainties uncorrelated)

Uncertainty in Cloud Effective Radius (Liquid Water) — April 1, 2005

$\Delta r_e / r_e$ (%)
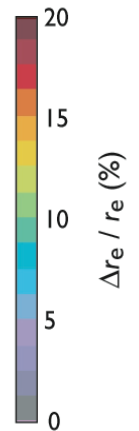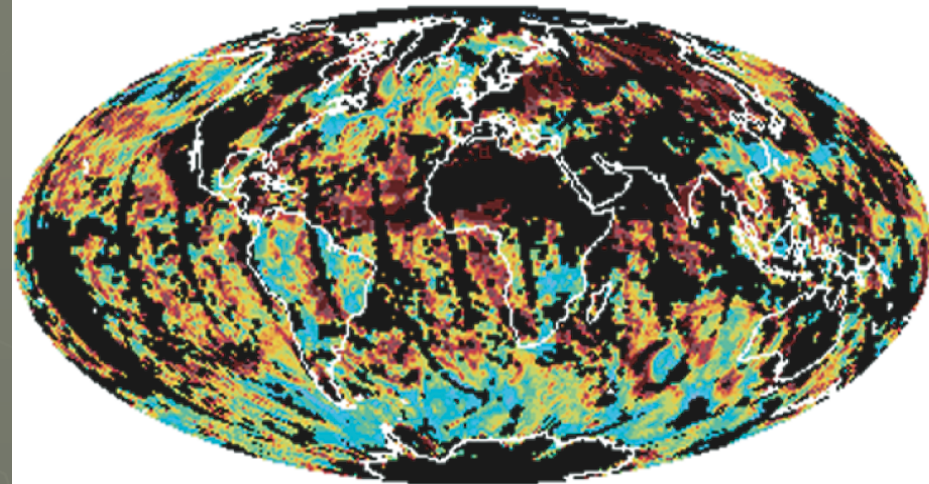
Uncertainty in Cloud Effective Radius (Liquid Water) — April 2005

$\Delta r_e / r_e$ (%)
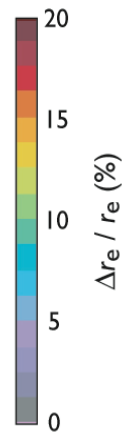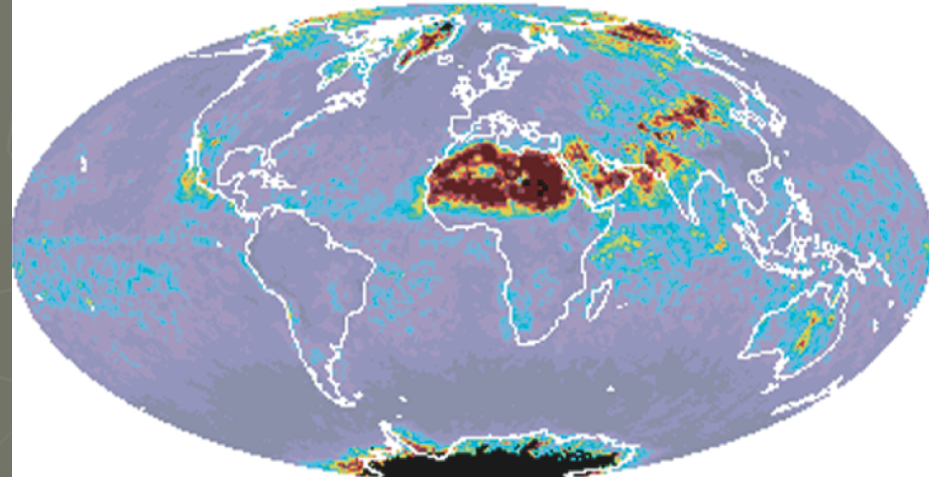
Multilayer Cloud Flag
(S. Platnick, M. D. King et al. – NASA GSFC)

April 2005 (Collection 5)
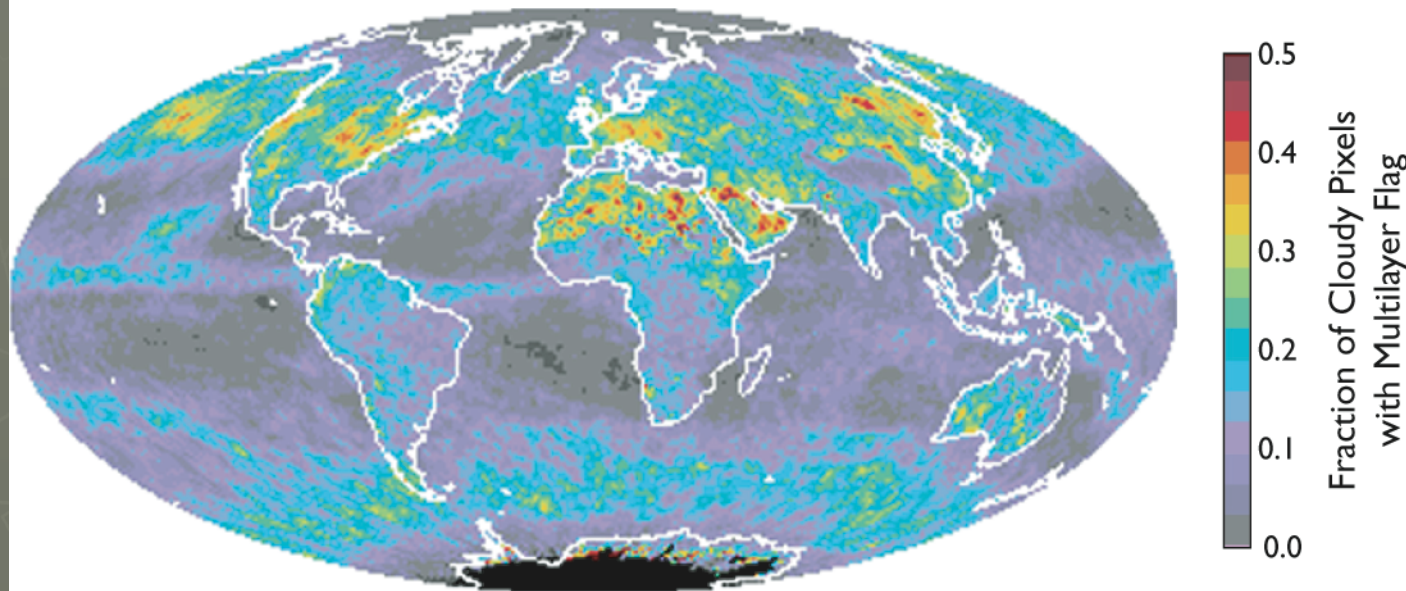
Aqua

California / California Current Regime
Monthly Joint Histogram Counts of Liquid Water Clouds over Ocean
32°-40°N, 117°-125°W
June 2005

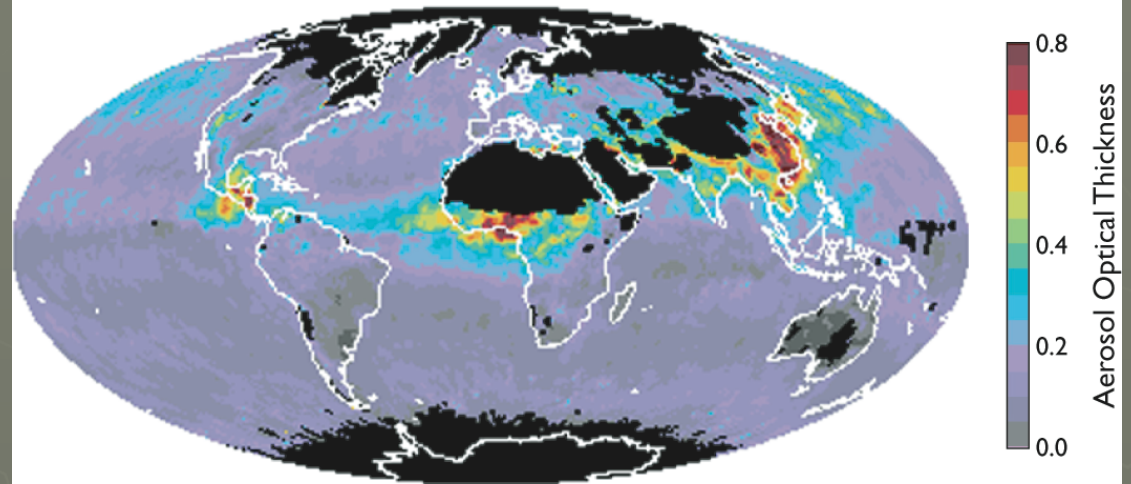Terra/MODIS (AM Overpass)

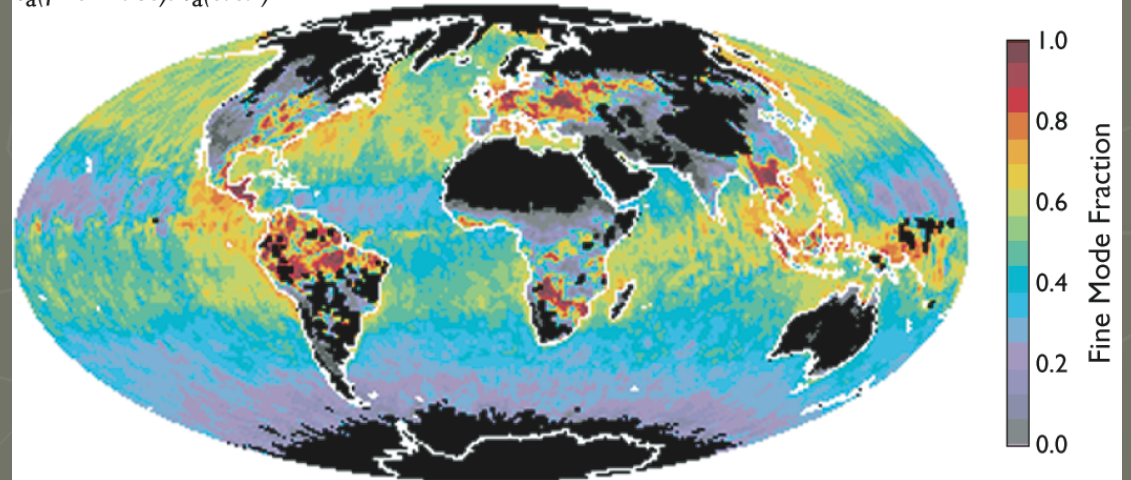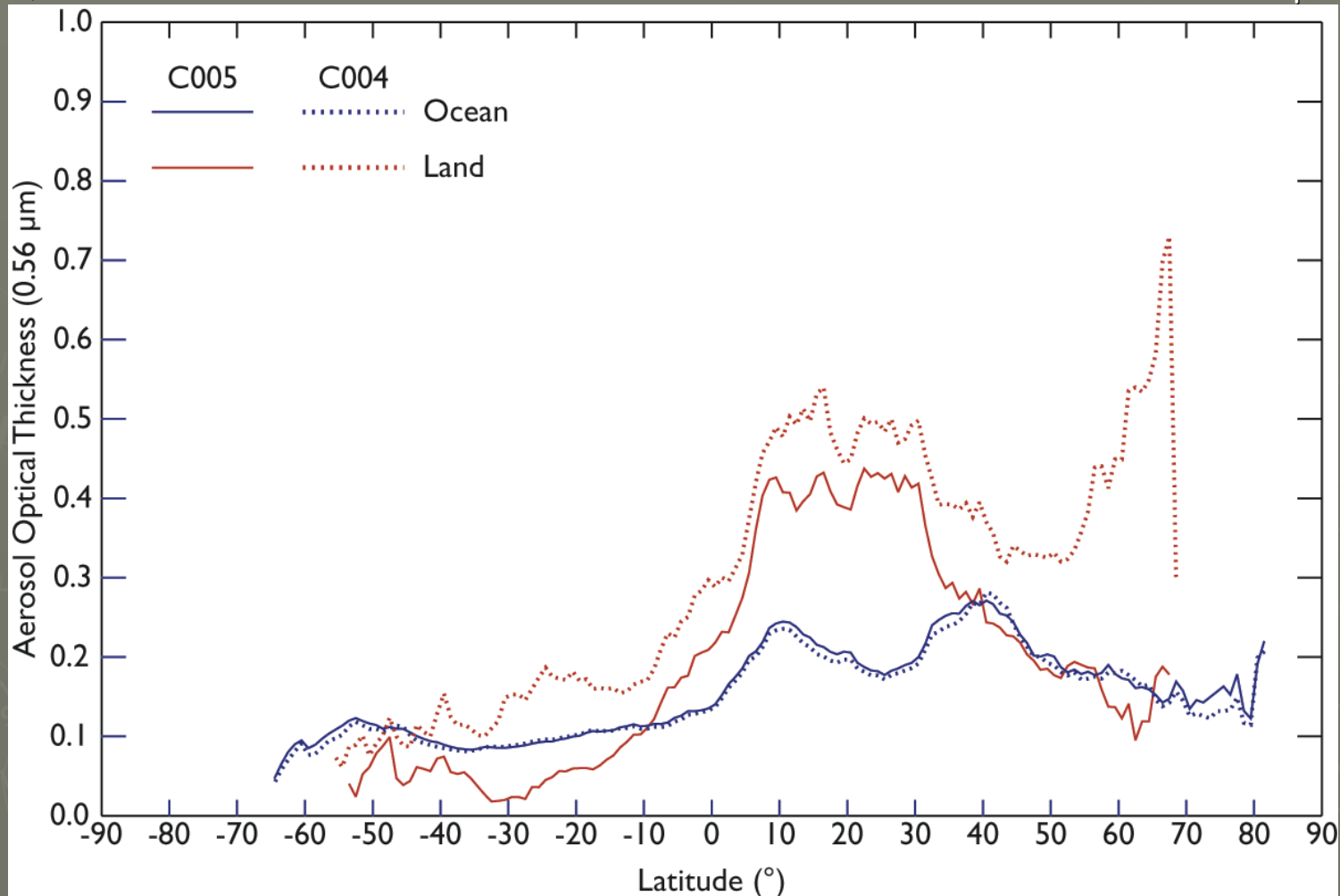Aqua/MODIS (PM Overpass)
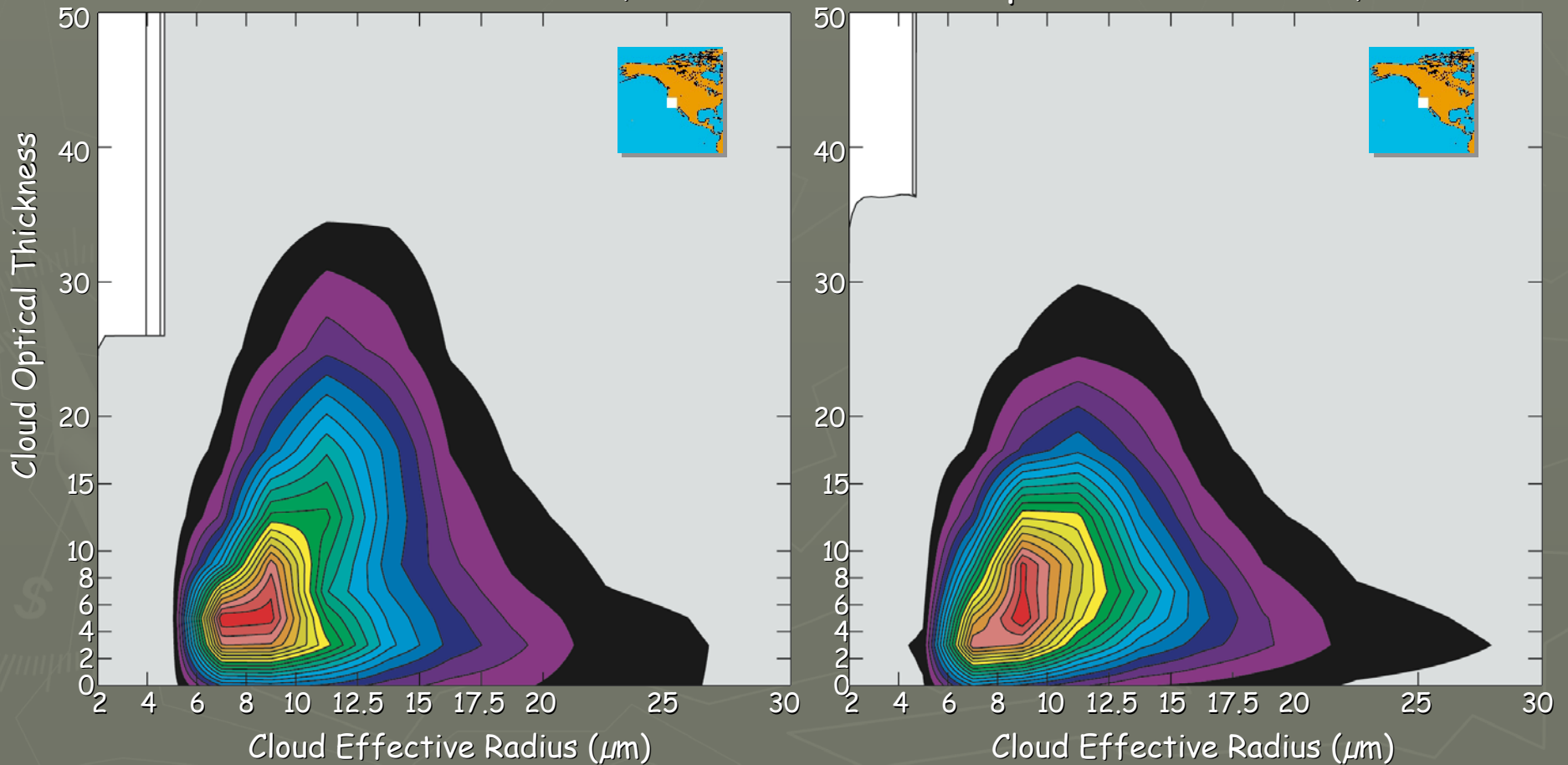
Monthly Mean Aerosol Optical Properties
(L. A. Remer, Y. J. Kaufman, and D. Tanré et al. – GSFC, Univ. Lille)

April 2005 (*Collection 5*)

Aqua

Zonal Mean Aerosol Optical Thickness
(L. A. Remer, Y. J. Kaufman, and D. Tanré et al. – GSFC, Univ. Lille)

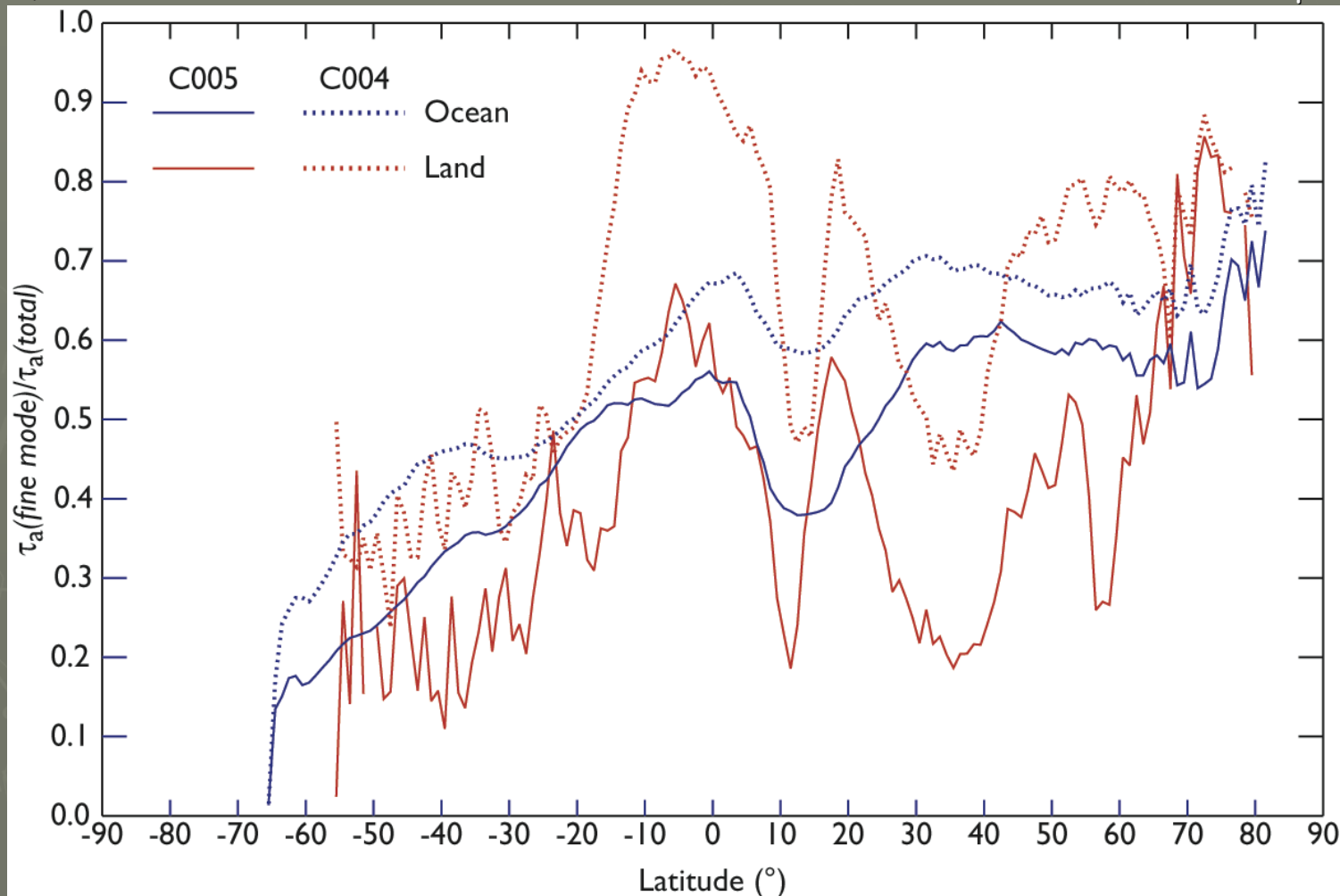*April 2005 (Collection 5)*   *Aqua*

Zonal Mean Aerosol Fine Mode Fraction
## (L. A. Remer, Y. J. Kaufman, and D. Tanré et al. – GSFC, Univ. Lille)

April 2005 (Collection 5)

Aqua

Deep Blue Algorithm for SeaWiFS & MODIS
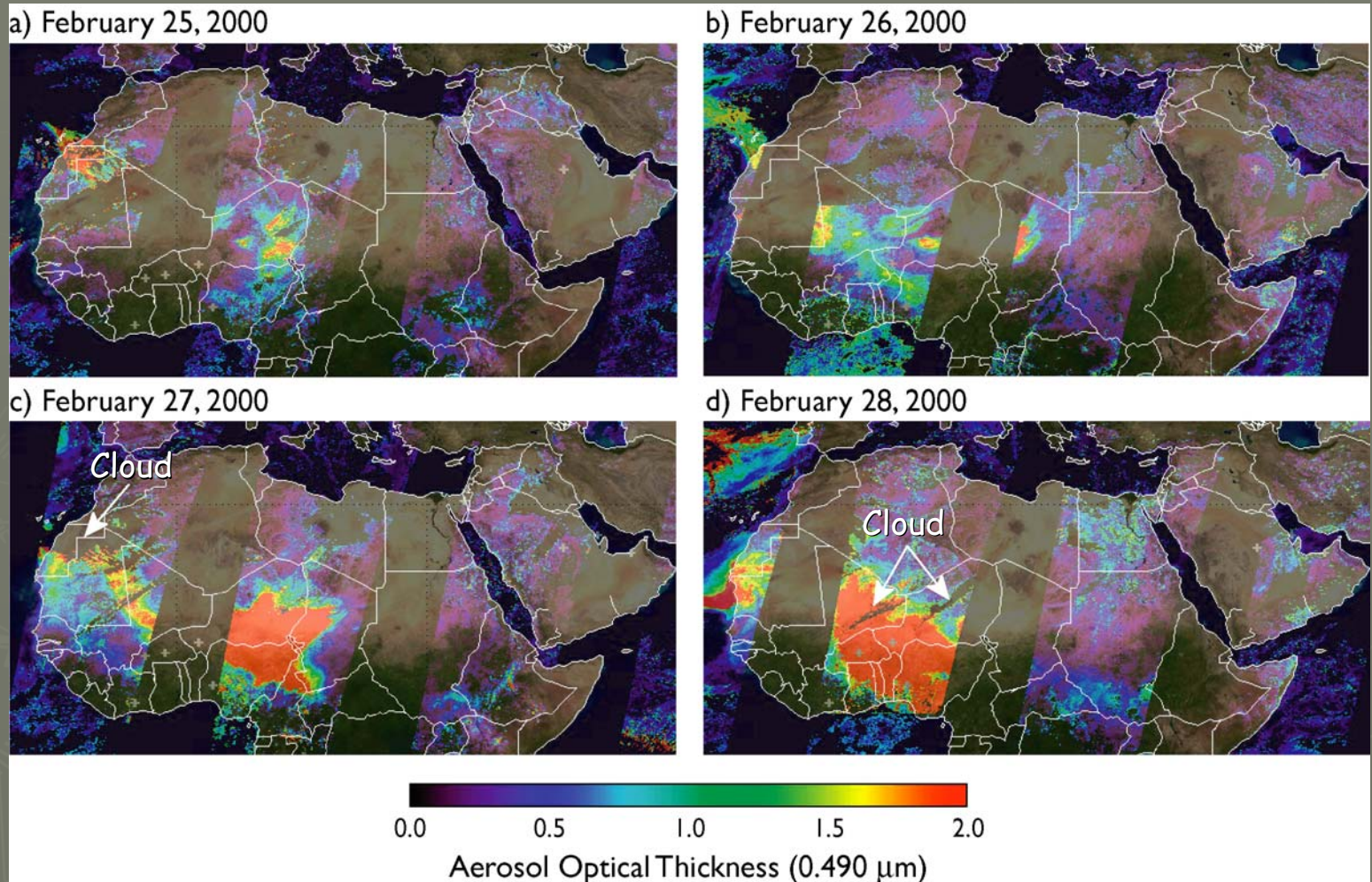## (N. C. Hsu, S. C. Tsay, M. D. King, and J. R. Herman – NASA GSFC)

- Utilize solar reflectance at λ = 412, 490, and 670 nm to retrieve aerosol optical thickness (τ_a) and single scattering albedo (ω_o)

- Less sensitive to aerosol height, compared to UV methods

- Works well on retrieving aerosol properties over various types of surfaces, including very bright desert

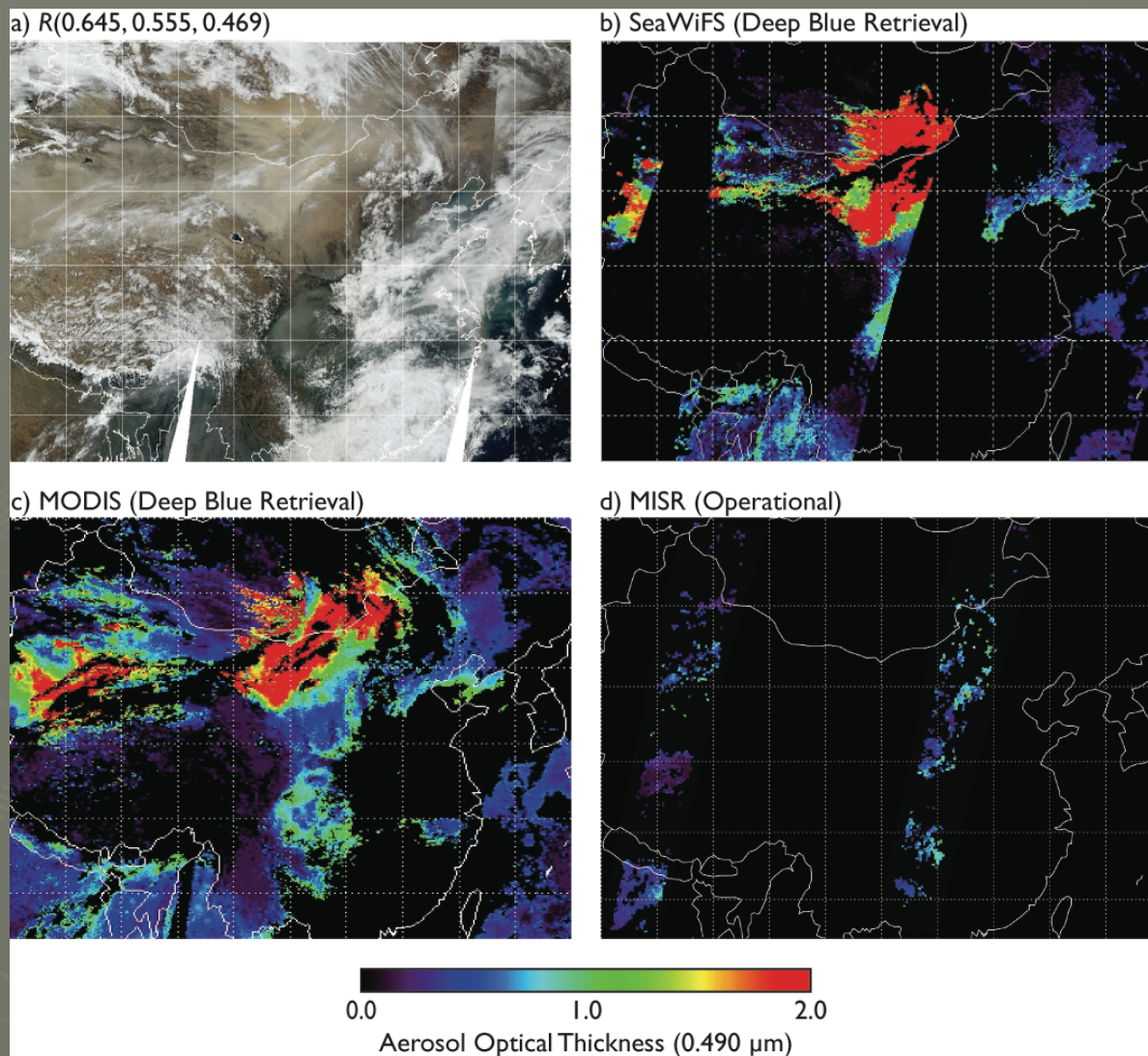Hsu et al. (2004)
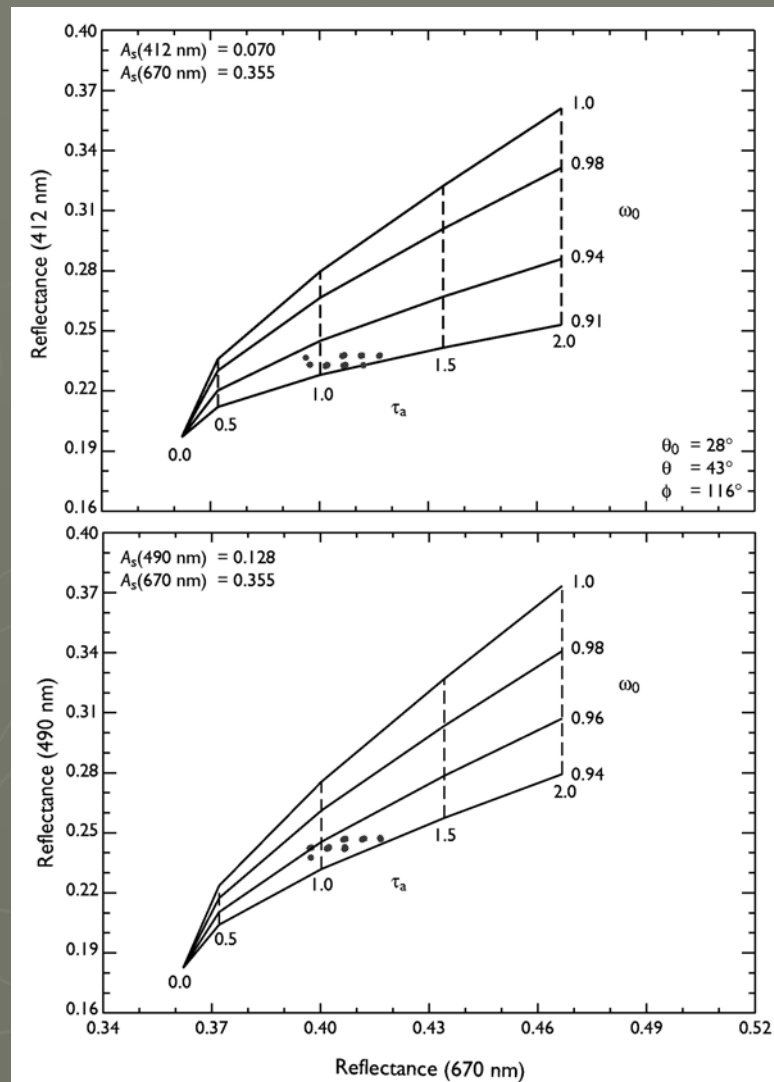
Aerosol Optical Thickness of Dust plumes in Africa
(N. C. Hsu, S. C. Tsay, M. D. King, and J. R. Herman – NASA GSFC)

SeaWiFS

a) February 25, 2000
b) February 26, 2000
c) February 27, 2000
d) February 28, 2000

Cloud

Cloud

0.0   0.5   1.0   1.5   2.0

Aerosol Optical Thickness (0.490 μm)

Hsu et al. (2004)

Aerosol Optical Thickness of Dust plumes in Asia
(N. C. Hsu, S. C. Tsay, M. D. King, and J. R. Herman – NASA GSFC)

a) R(0.645, 0.555, 0.469)

b) SeaWiFS (Deep Blue Retrieval)

c) MODIS (Deep Blue Retrieval)

d) MISR (Operational)

0.0   1.0   2.0
Aerosol Optical Thickness (0.490 µm)

Hsu et al. (2006)

MODIS Deep Blue Algorithm over the Middle East
(N. C. Hsu , S. C. Tsay, M. D. King – NASA GSFC)

August 7, 2005

True Color Composite (0.65, 0.56, 0.47)

Aerosol Optical Thickness

Syria

Iran

Iraq

Saudi Arabia

Persian Gulf

0.0   0.5   1.0   1.5   2.0   2.5
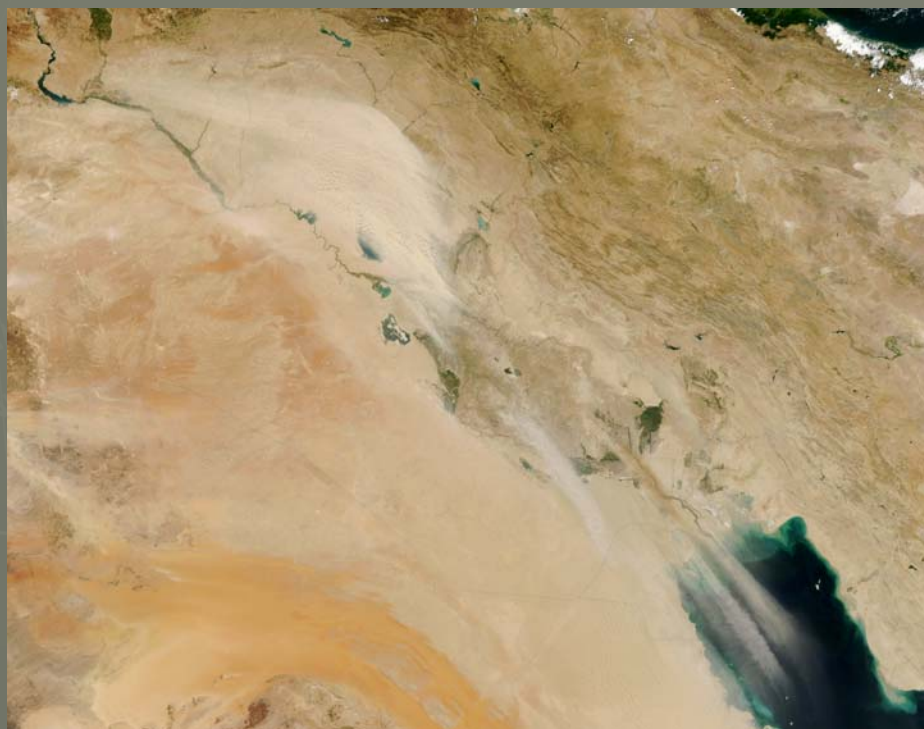
Aerosol Optical Thickness
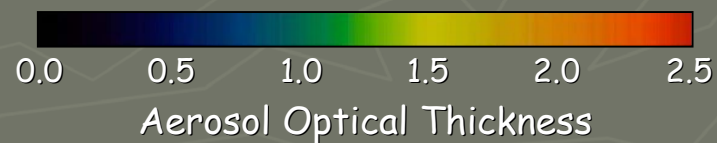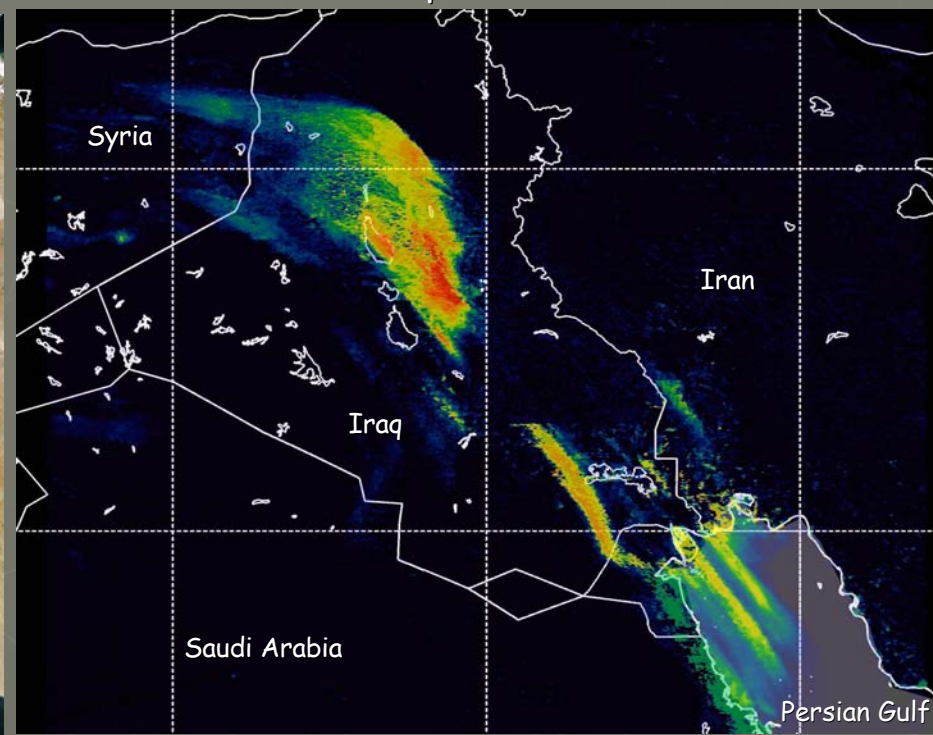
Monthly Mean Precipitable Water
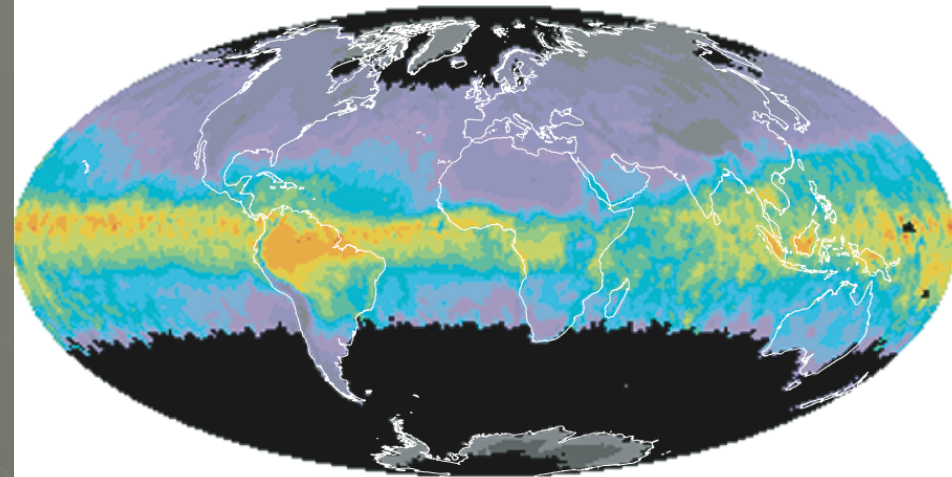## (B. C. Gao, S. W. Seemann, J. Li, W. P. Menzel – NRL, Univ. Wisconsin)

April 2005 (Collection 5)

Aqua

Daytime Land & Sunglint

(1 km pixels)

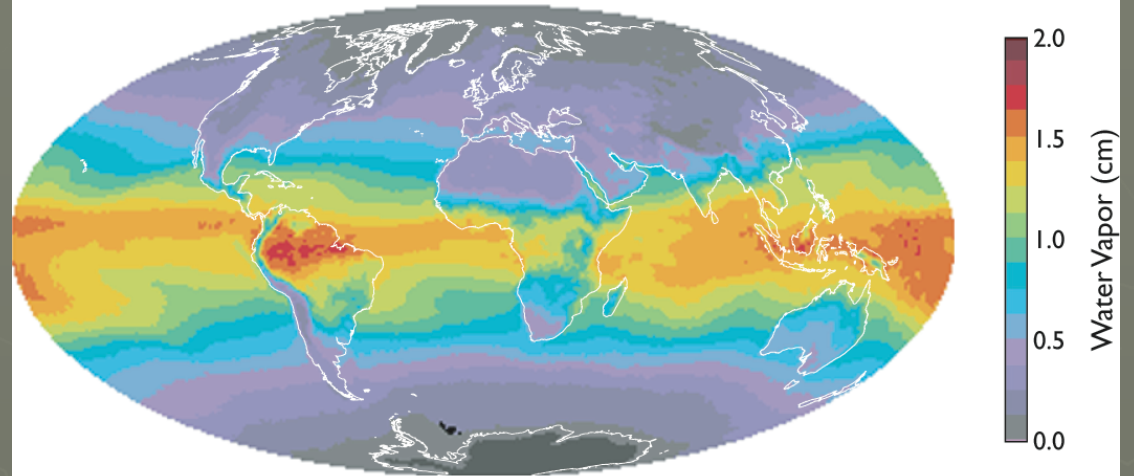Daytime & Nighttime

(5 km pixels)
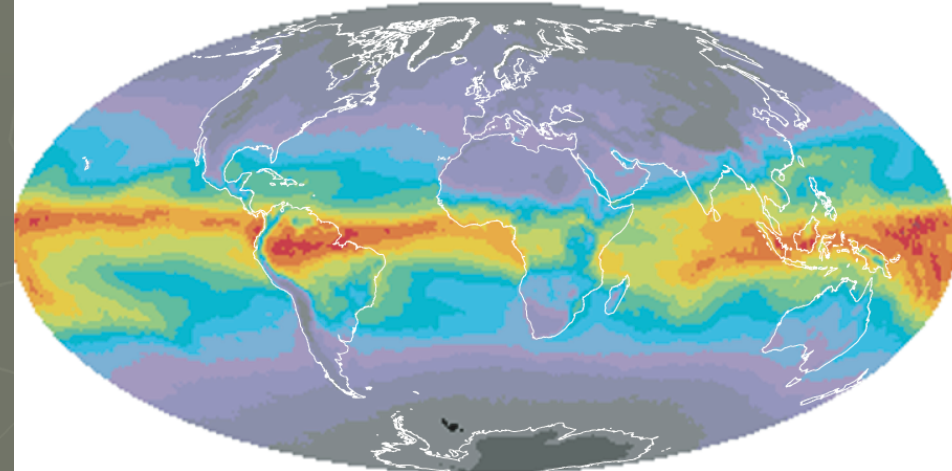
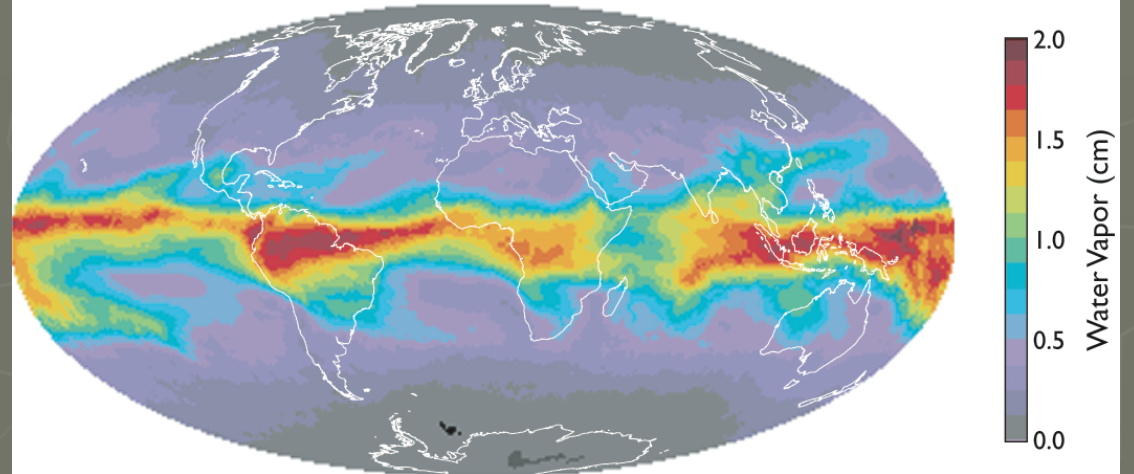# Monthly Mean Water Vapor
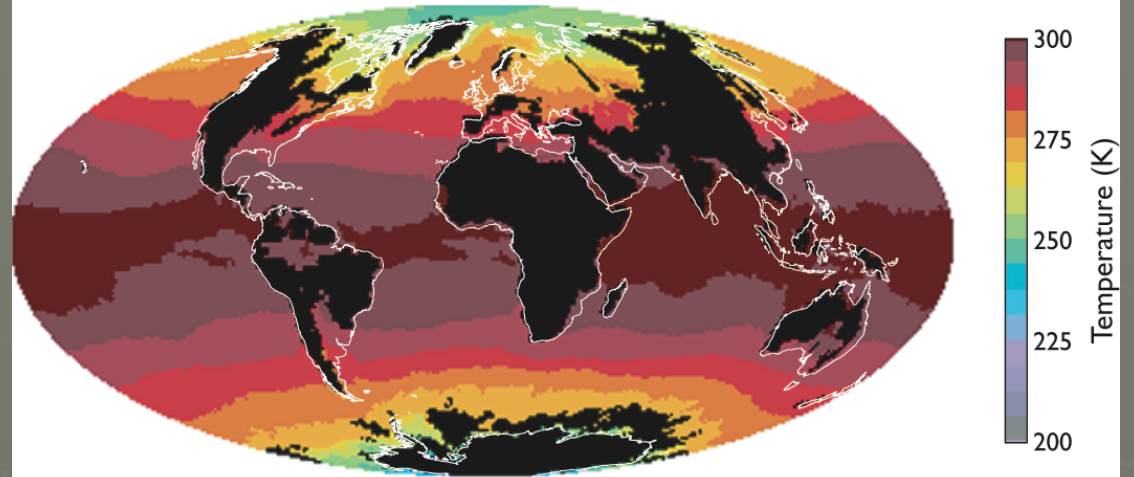## (S. W. Seemann, J. Li, W. P. Menzel – Univ. Wisconsin, NOAA)

April 2005 (Collection 5)

Aqua

Monthly Mean Temperature Profile
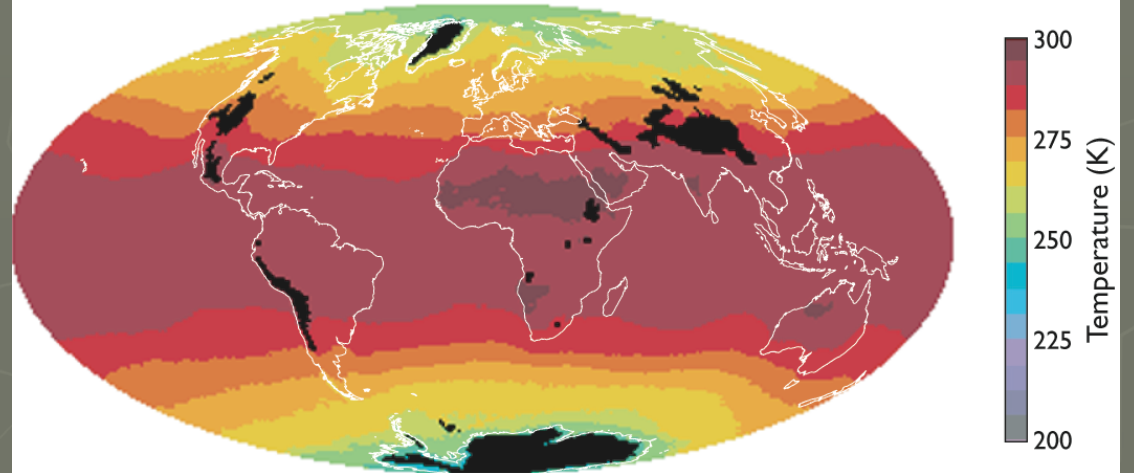## (S. W. Seemann, J. Li, W. P. Menzel – Univ. Wisconsin, NOAA)

April 2005 (Collection 5)

Aqua

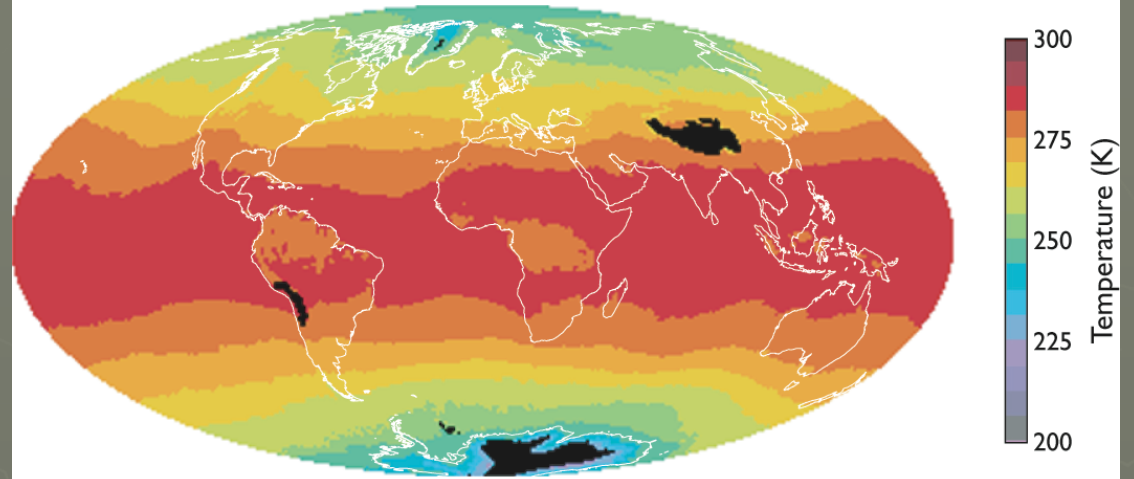# Monthly Mean Temperature Profile
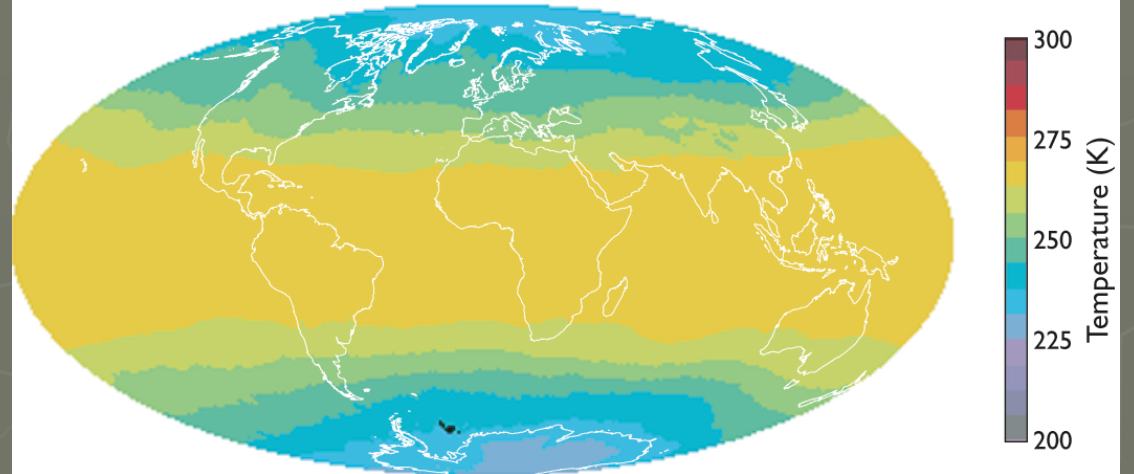## (S. W. Seemann, J. Li, W. P. Menzel – Univ. Wisconsin, NOAA)
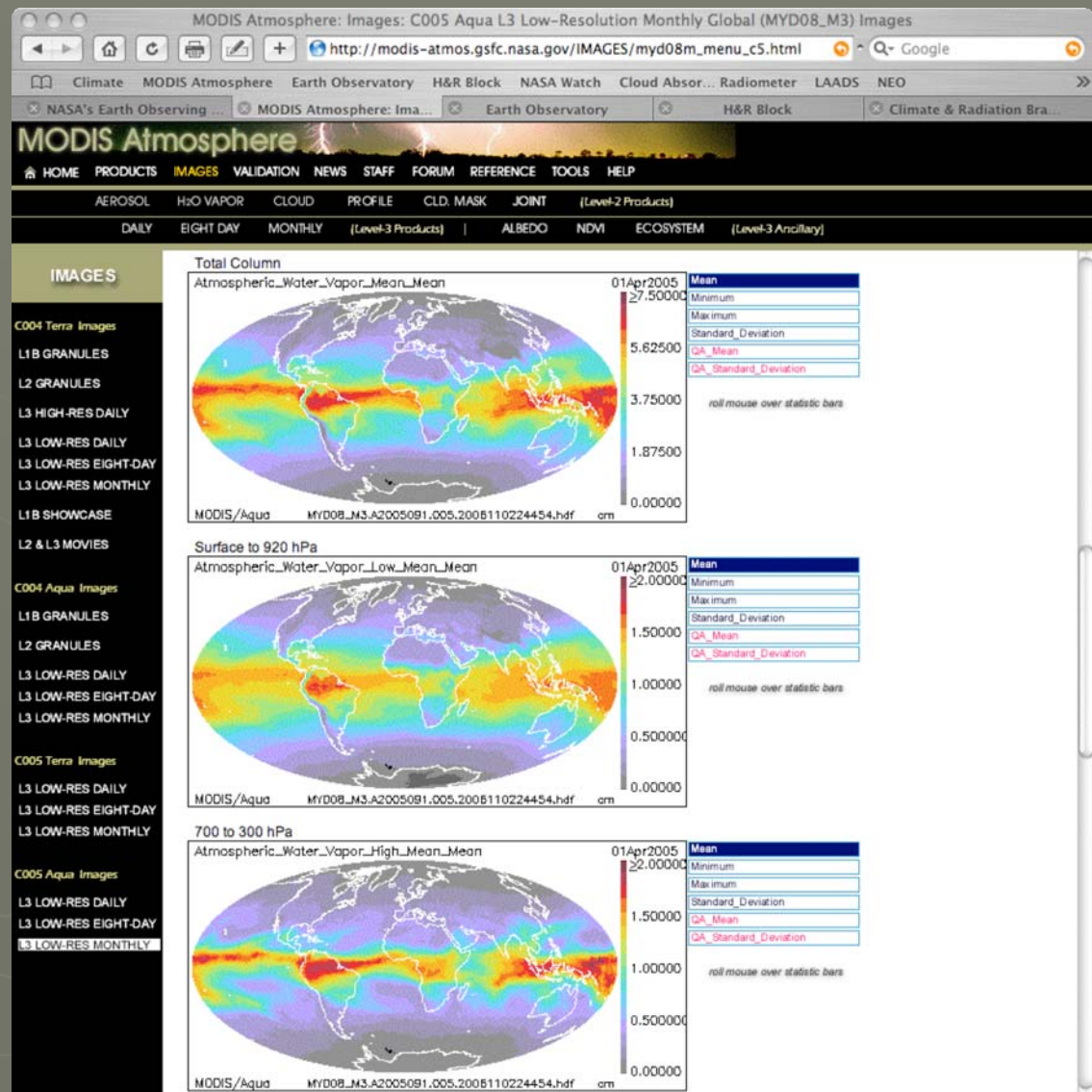
April 2005 (Collection 5)

Aqua

MODIS Level-3 Monthly Global Browse Images

- ➢ Aerosol Land & Ocean
- ➢ Aerosol Land Only
- ➢ Aerosol Ocean Only
- ➢ Water Vapor
- ➢ Cirrus Detection
- ➢ Cloud Top Properties
- ➢ Cloud Optical Properties
- ➢ Atmospheric Profile

modis-atmos.gsfc.nasa.gov

Summary and Resources

- ➢ Terra and Aqua
  - MODIS atmosphere products (descriptions, level-1b and level-3 browse imagery, documentation, contact information, tools for working with and ordering data…)
    - ✓ modis-atmos.gsfc.nasa.gov
      - » MODIS online visualization and analysis system (Giovanni)
      - » MODIS surface albedo, ecosystem, and NDVI filled-in global data sets
  - Collection 5 enhancements and reprocessing
    - ✓ Atmosphere reprocessing of Aqua began on April 1, 2006 (January 2005 to present, then back to beginning of Aqua around July 4, 2002) and is now complete
    - ✓ Atmosphere reprocessing of Terra began on July 18, 2006 (January 2005 to present, then back to beginning of Terra around February 24, 2000) and is now in September 2001
    - ✓ Aqua and Terra forward stream near real-time
    - ✓ Data available for browse (level-1 and atmosphere level-2 and level-3) and ordering at Level 1 and Atmosphere Archive and Distribution System (LAADS)
      - » ladsweb.nascom.nasa.gov